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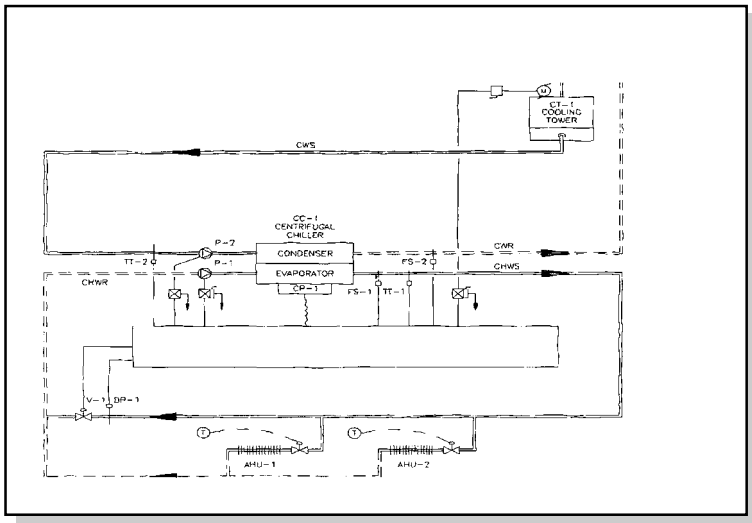
TEST 7 — CHILLED-WATER SYSTEM USING CENTRIFUGAL CHILLER, BASIC SYSTEM — DESIGN

Choose the correct answer (from the choices in bold) for each of the following hvac situations, referring to the schematic diagram on this page.

1 **On-off control in the "off" position:**
Centrifugal chiller CC-1 is off, chilled-water pump P-1 is off, condenser water pump P-2 is off, "draw-through" cooling tower fan is (**off, on**), and chilled-water system differential pressure control valve V-1 is open.

2 **On-off control in the "on" position:**
Centrifugal chiller CC-1 on-off switch at the unit control panel CP-1 is placed in the "on" position, but refrigerant process does not start. Interlock control signals from chiller control panel CP-1 to chilled-water pump P-1 and condenser water pump P-2. Start both pumps. Chilled-water flow switch (**FS-1, FS-2, DP-1**) senses flow and confirms P-1 is delivering sufficient flow for CC-1 to start. Condenser water flow switch FS-2 senses flow and confirms P-2 is delivering sufficient flow for CC-1 to start. CC-1 centrifugal refrigeration cooling process begins.



3 **On-off control in the "on" position:**
With chilled-water flow, system pressure will begin to increase and differential pressure transmitter DP-1 shall begin to control the open-to-close sequence noted below. Chilled-water supply temperature control transmitter (**TT-1, TT-2, DP-1**), set at 45 F, shall maintain supply water temperature setpoint by modulating the chiller CC-1 self-contained centrifugal refrigeration controls in control panel CP-1.

4 **On-off control in the "on" position:**
Condenser water supply temperature control transmitter TT-2, set at (**45 F, 85 F, 105 F**), shall maintain supply water temperature setpoint by starting and stopping cooling tower CT-1 fan. On a rise in condenser water supply temperature, 5 F above 85 F, CT-1 fan shall (**stop, start**). When condenser water temperature drops below the 85 F setpoint, CT-1 fan shall stop.

5 **Maximum cooling:**
Chiller CC-1 shall be providing maximum cooling capacity and differential pressure valve V-1 shall be (**open, closed**). Air-handling units' straight-through chilled-water valves shall be open 100%, drawing off all the chilled water for space cooling and/or dehumidification needs. Cooling tower CT-1 fan shall be operating continuously.

6 **Minimum cooling:**
Chiller CC-1 shall be providing (**minimum, maximum**) cooling capacity and differential pressure valve V-1 shall be open (**0%, 50%, 100%**) to maintain sufficient chilled-water flow through CC-1. Air-handling units' straight-through chilled-water valves shall be modulated toward the closed position, reducing the need for chilled water for space cooling and/or dehumidification. Cooling tower CT-1 fan shall be off.

7 **Differential pressure control:**
Valve V-1 shall be normally open and modulate toward closed as differential pressure control transmitter signals a (**rise, drop**) in chilled-water system pressure, below the design operating pressure. When chilled-water supply pressure begins to exceed the design pressure setpoint, DP-1 shall signal (**TT-1, TT-2, V-1**) to begin to modulate towards open again.

HELPFUL HINTS:

There can be a wide array of sequence of operations for a centrifugal chiller. For example, a design engineer may consider the following:

- Three-way valves, in lieu of straight-through chilled-water valves at air handling units; if this is the case, the differential pressure valve and associated pressure transmitter can be eliminated.
- If the cooling tower is a blow-through type, automatic damper control at CT-1 fan may be required to be added to control the condenser water supply temperature.

The design engineer should pay special attention to refrigerant code criteria. Know which ASHRAE Standard 15 (1989, 1992 or 1994) is applicable for your state. In all cases, refrigerant monitoring and emergency exhaust air evacuation is required.

When providing conceptual centrifugal chiller design, some useful rule-of-thumb assumptions are:

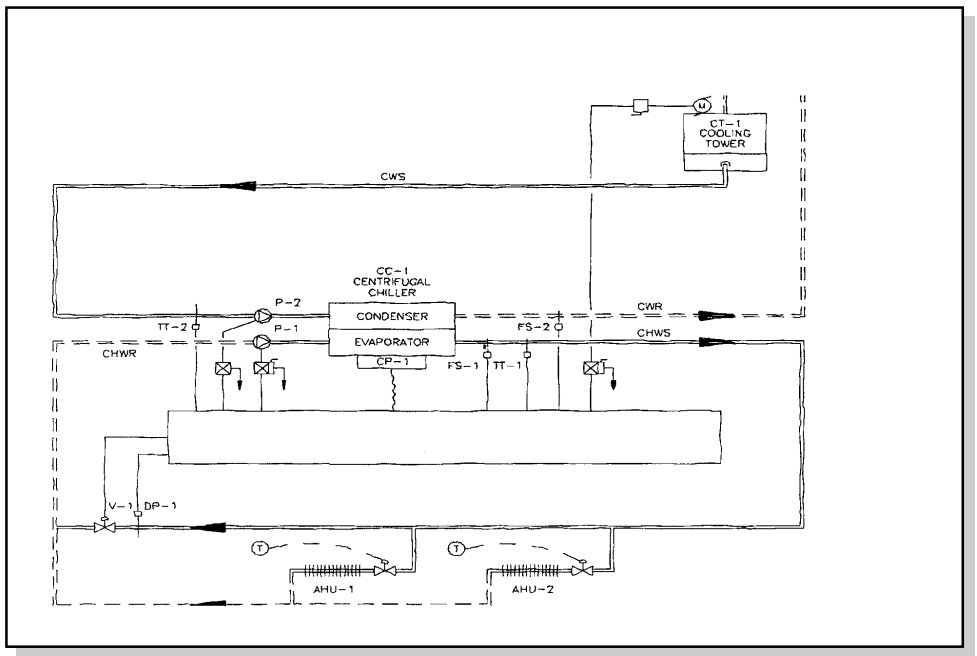
- 2.5 gpm per ton for chilled-water capacity;
- 3.0 gpm per ton for condenser-water capacity;
- 70-ft chilled-water pump head; and
- 90-ft condenser-water pump head.

If you have any questions regarding the Basic System — Commissioning test, fax your concerns, questions, and/or comments to: Rebecca Ellis, P.E., 612-546-0494.

ANSWERS FOR BASIC SYSTEM — COMMISSIONING: 1. c) stop; **1.** d) opens; **2.** a) pumps; **3.** a) refrigerant process; **4.** a) starts; **4.** b) stops; **5.** a) closed; **6.** a) opens fully.

TEST 8 — CHILLED-WATER SYSTEM USING CENTRIFUGAL CHILLER, BASIC SYSTEM — COMMISSIONING

Choose the correct answer (from the choices in bold) for each of the following hvac situations, referring to the schematic diagram on this page.



1 Turn chiller off and verify that:
a) Refrigerant process stops.
b) Cooling tower fan stops.
c) Pumps P-1 and P-2 (stop, start).
d) Differential pressure control valve V-1 (opens, closes).

2 Turn chiller on and verify that:
a) The (cooling tower fan, pumps, refrigerant process) start(s) first.
b) Refrigerant process starts after both flow switches, FS-1 and FS-2, confirm water flow.

3 Reset chilled-water supply temperature setpoint to 2°F lower than the current TT-1 temperature reading. Verify that:
a) The chiller panel CP-1 controls (refrigerant process, pump P-1) to maintain chilled-water temperature steady at the new set-point.

4 Reset condenser water supply temperature setpoint to 8°F lower than current TT-2 temperature reading. Verify that:
a) Cooling tower fan (starts, stops).
b) When condenser water temperature falls to the new setpoint, the cooling tower fan (stops, starts).

5 Rest the system differential pressure setpoint to 5 psi higher than the current DP-1 pressure reading. Verify that:
a) Bypass valve V-1 modulates (open, closed) as required to achieve the new differential pressure setpoint and maintain it steady.

6 Reset system differential pressure setpoint to 0 psi. Verify that:
a) Bypass valve V-1 (opens fully, closes fully, modulates), attempting to achieve the new setpoint differential pressure.

7 Return all setpoints to their original values:
a) Chilled-water temperature.
b) Condenser water temperature.
c) System differential pressure.

If you have any questions regarding the Basic System — Design test, fax your concerns, questions, and/or comments to: Howard McKew, P.E., 978-887-1116 (fax); or via e-mail to hmckew@sebesta.com.

ANSWERS FOR BASIC SYSTEM — DESIGN 1. off; 2. FS-1; 3. TT-1; 4. 85°F, start; 5. closed; 6. minimum, 100%; 7. drop, V-1.